Impacts of Withdrawals on Streamflow
Misconceptions vs. Science

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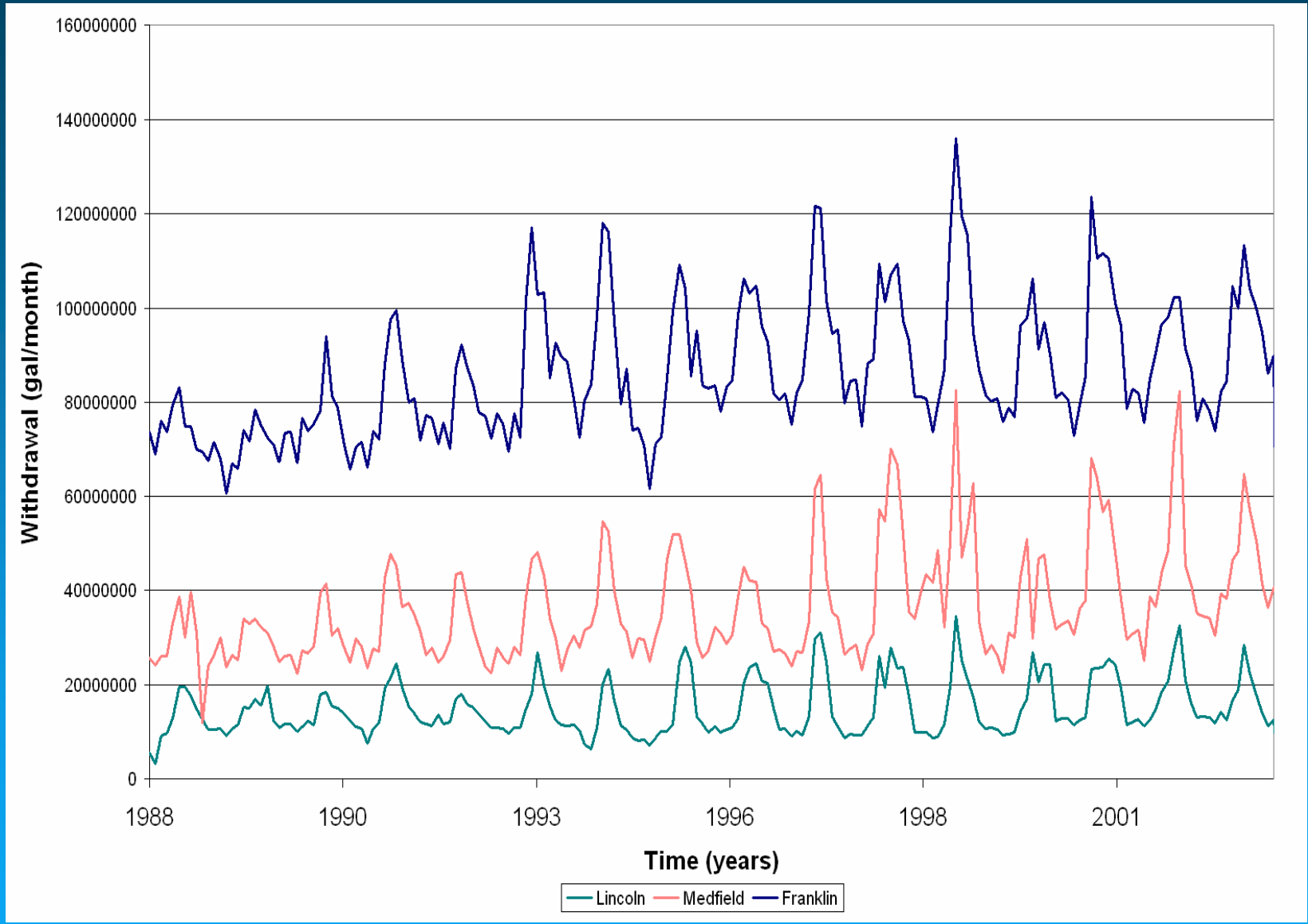
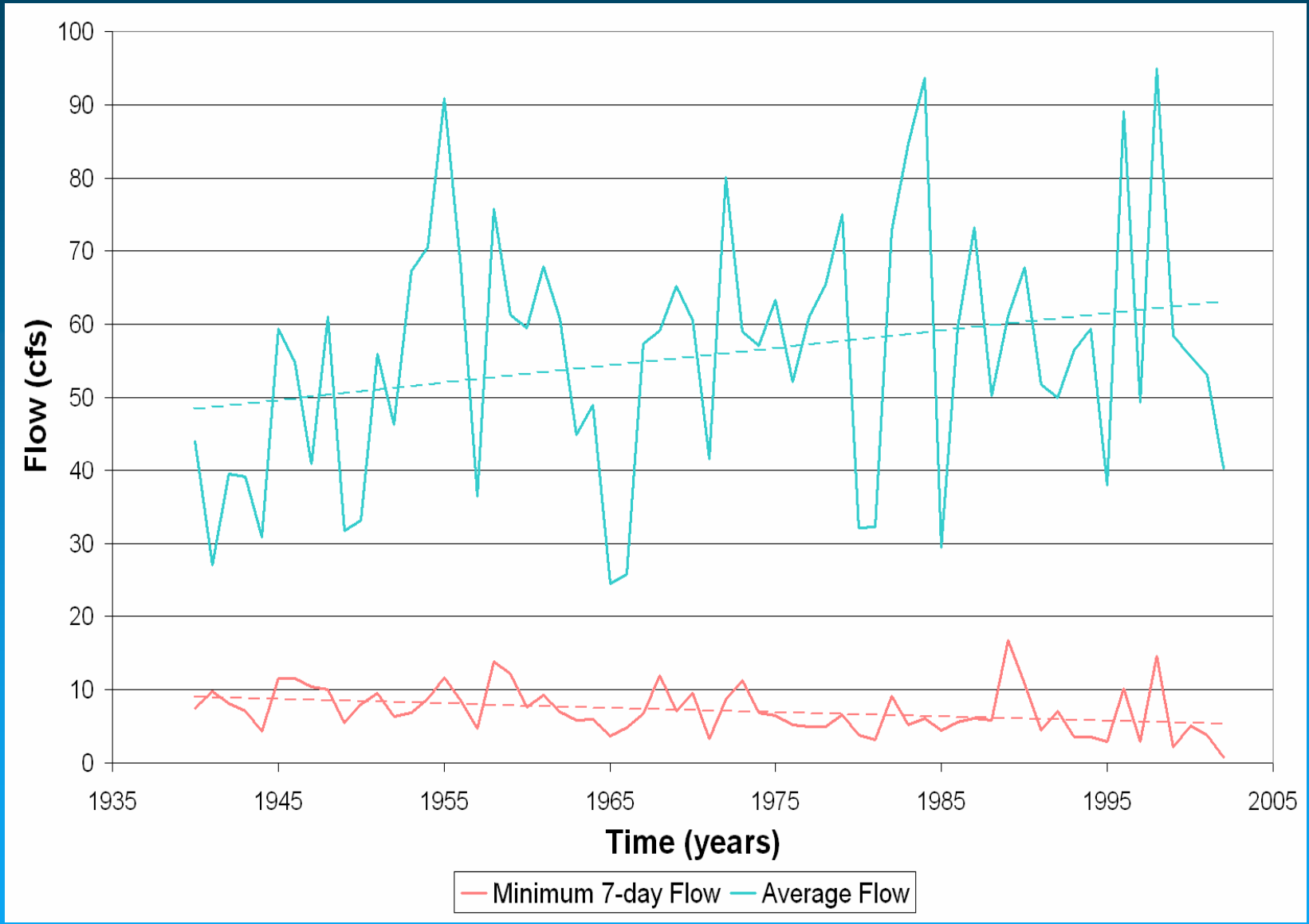
Urban Impacts on Streamflow

- Natural flow is a function of:
  - precipitation, ET, slope, soils, vegetation
- Actual flow is impacted by:
  - increased annual withdrawals from population
  - increased summer withdrawals from irrigation
  - increased runoff/less recharge from impervious and compacted areas
  - export of wastewater water via sewer systems

Water Withdrawals for Select Towns in the Charles



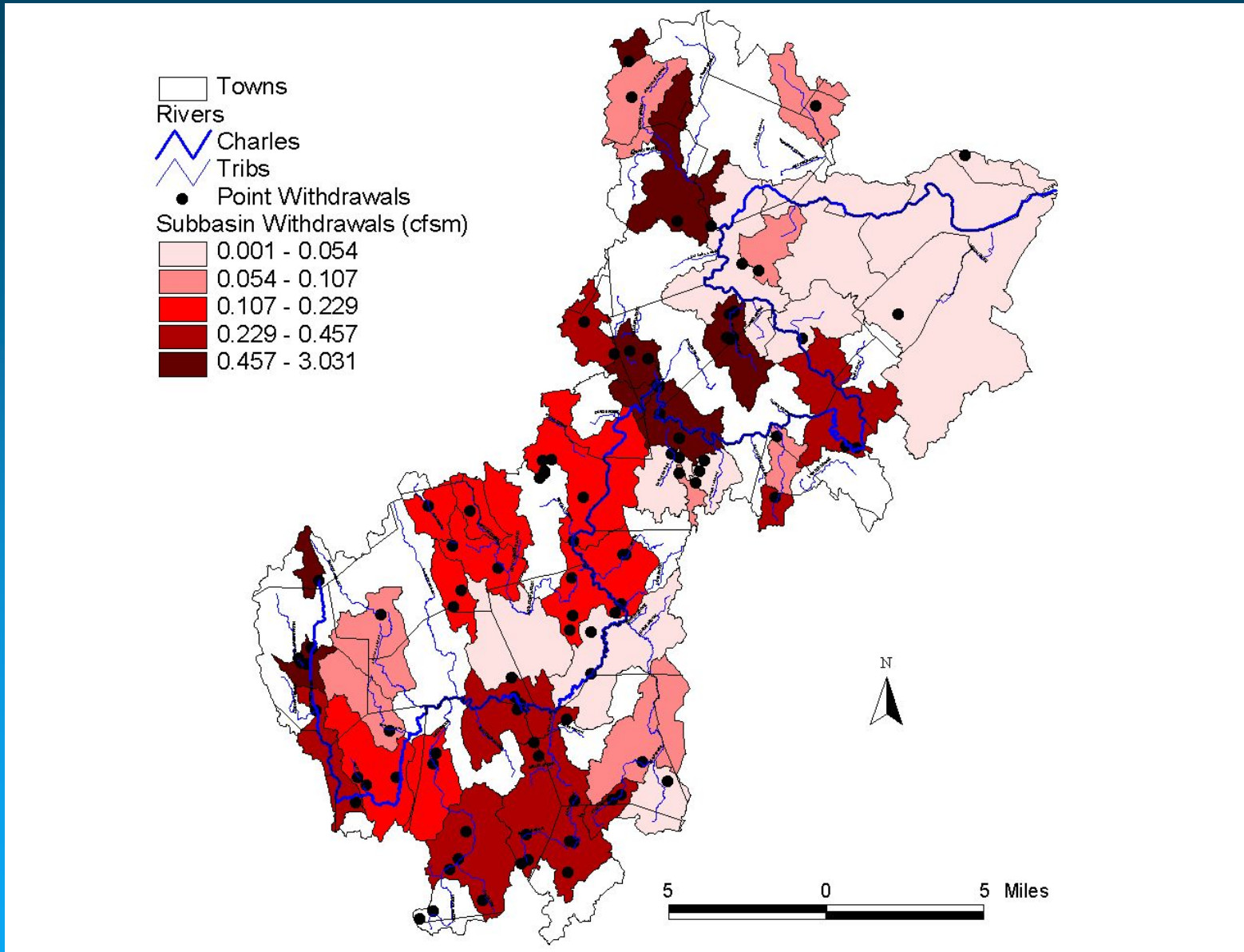
Flow Response to Growth - Neponset R at Norwood



Streamflow Impacts

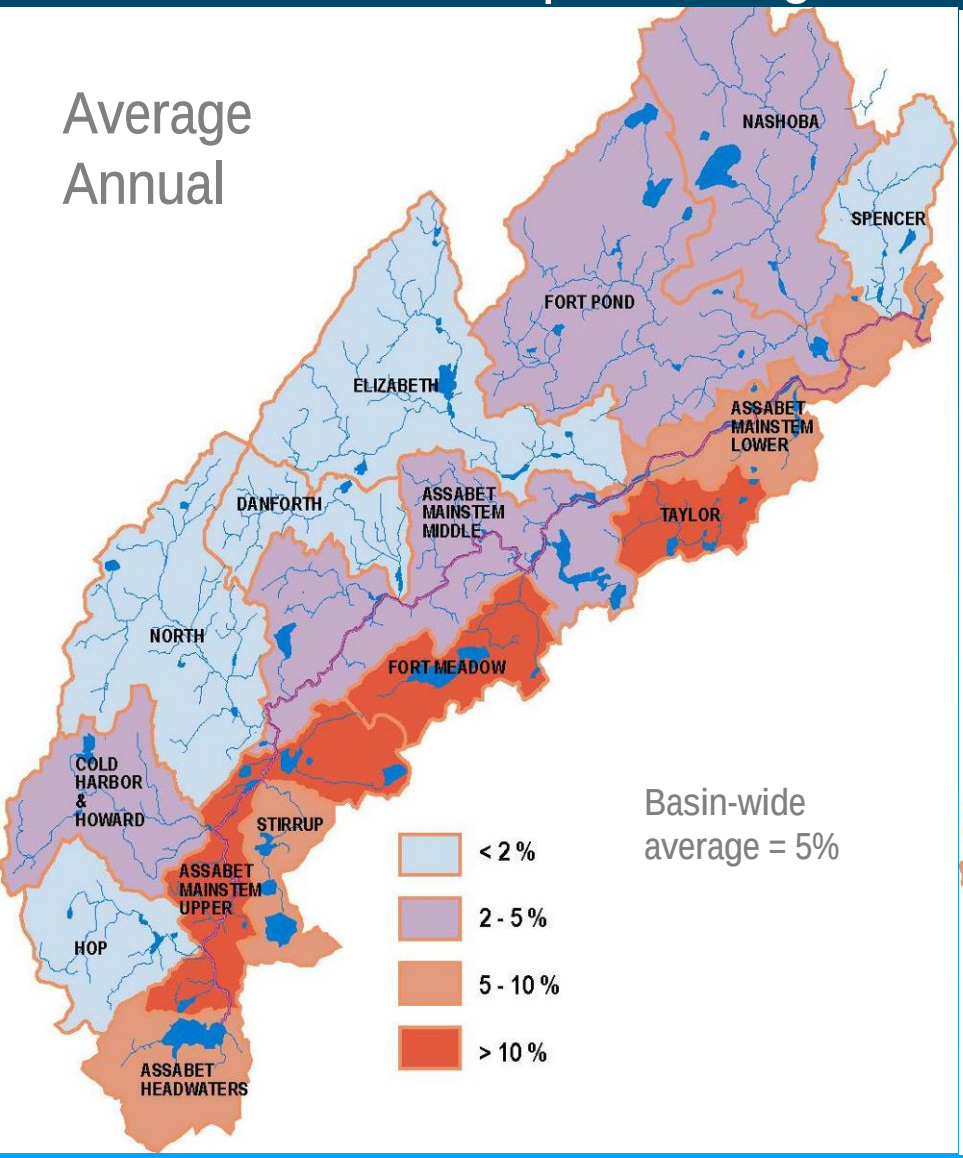
- Misconception
  - water withdrawals are not the major problem
  - wastewater export and impervious surfaces are the bigger problems

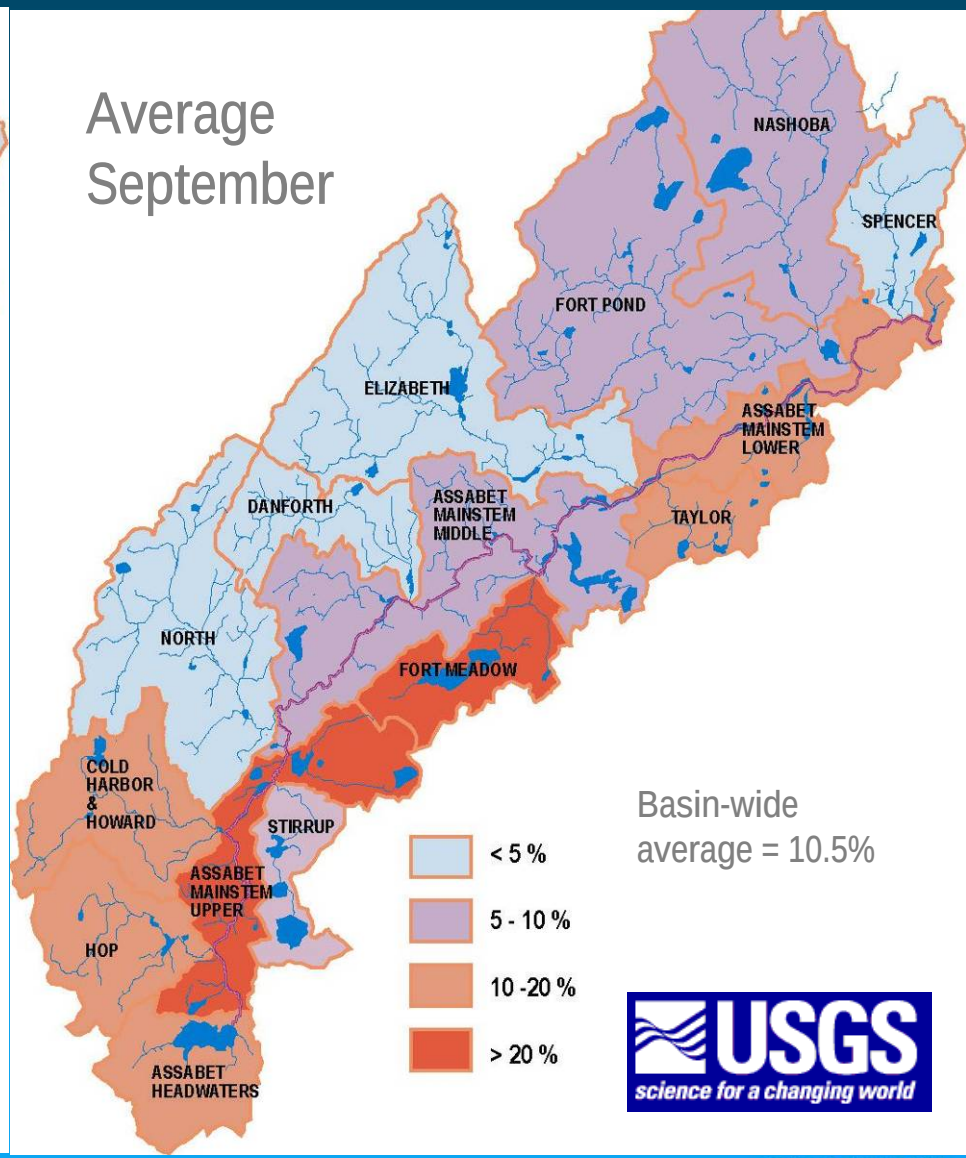
Summertime Withdrawals by Subbasin in Charles R



Subbasin Water Balances, Assabet Basin:

Withdrawals as a percentage of total subbasin outflows





USGS science for a changing world

From DeSimone, USGS SIR 2004-5114

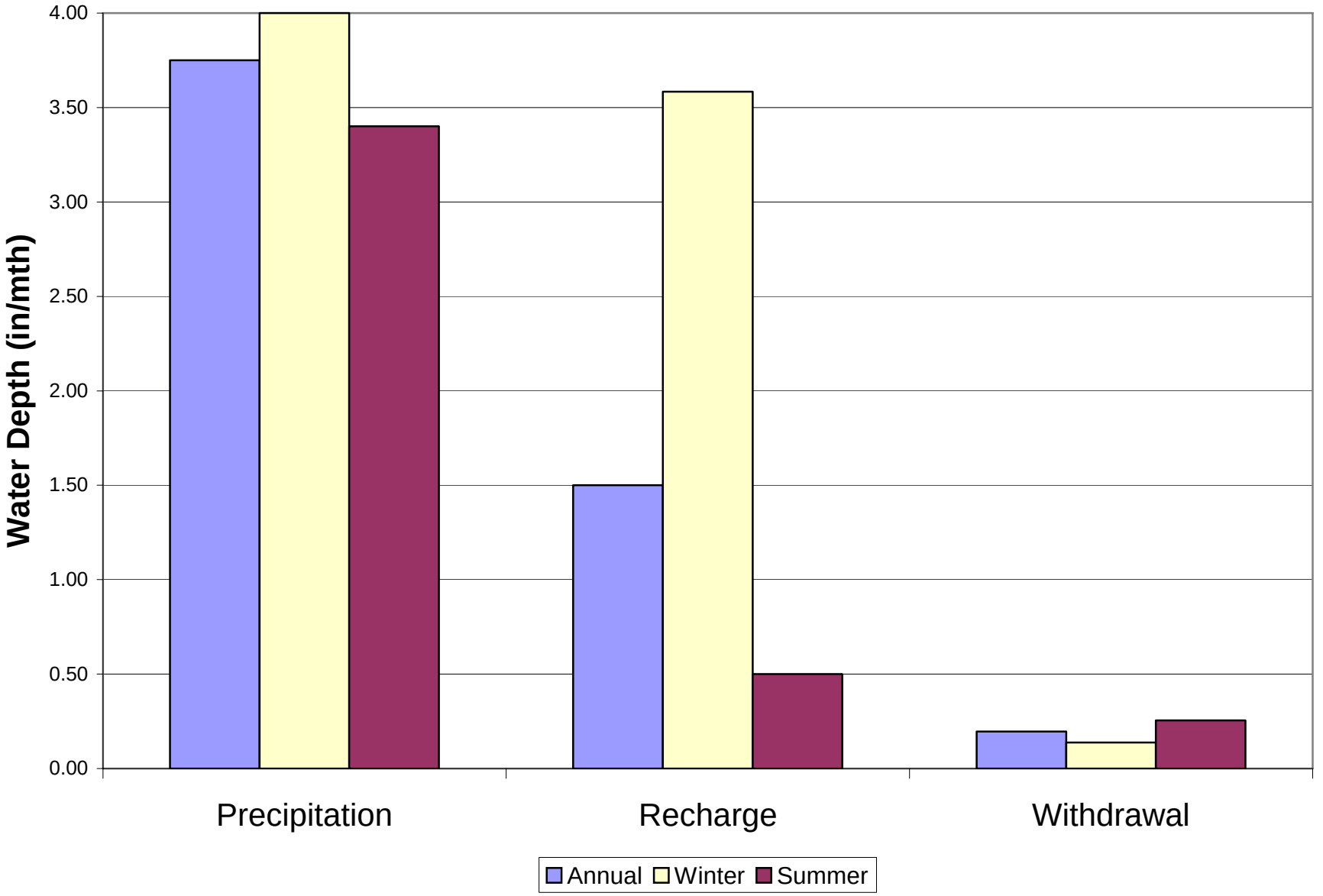
Streamflow Impacts

- Science
  - wastewater export and impervious surfaces do lower streamflow but they are a diffuse impact
  - water withdrawals are a localized or point impact and are cumulative
  - impact is patchy—magnitude depends on source and its location

Supply vs. Demand

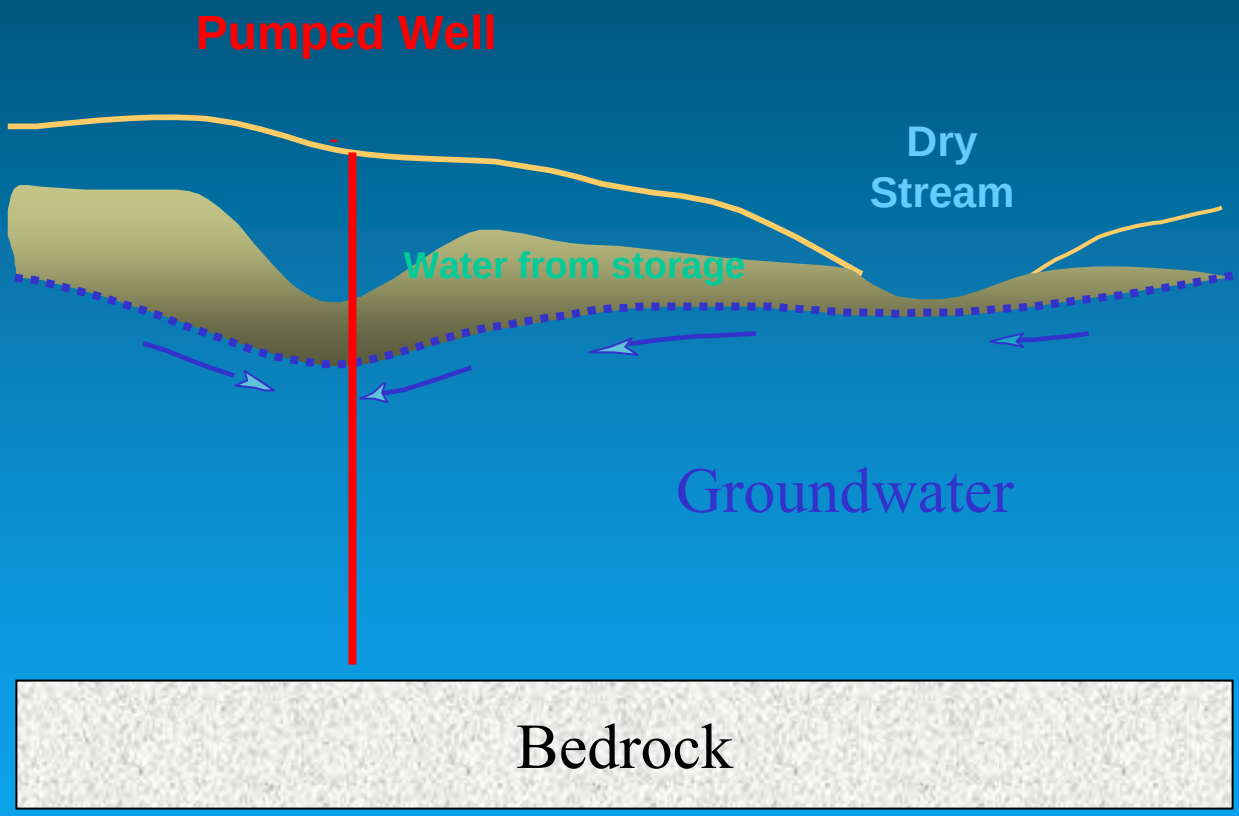
- Misconceptions
  - water supply is sufficient because withdrawals only take a small fraction of annual precipitation
  - there must be plenty of water because wells never run dry

Supply vs. Demand



Ample Groundwater with a Dry River

Ipswich River is a Prime Example



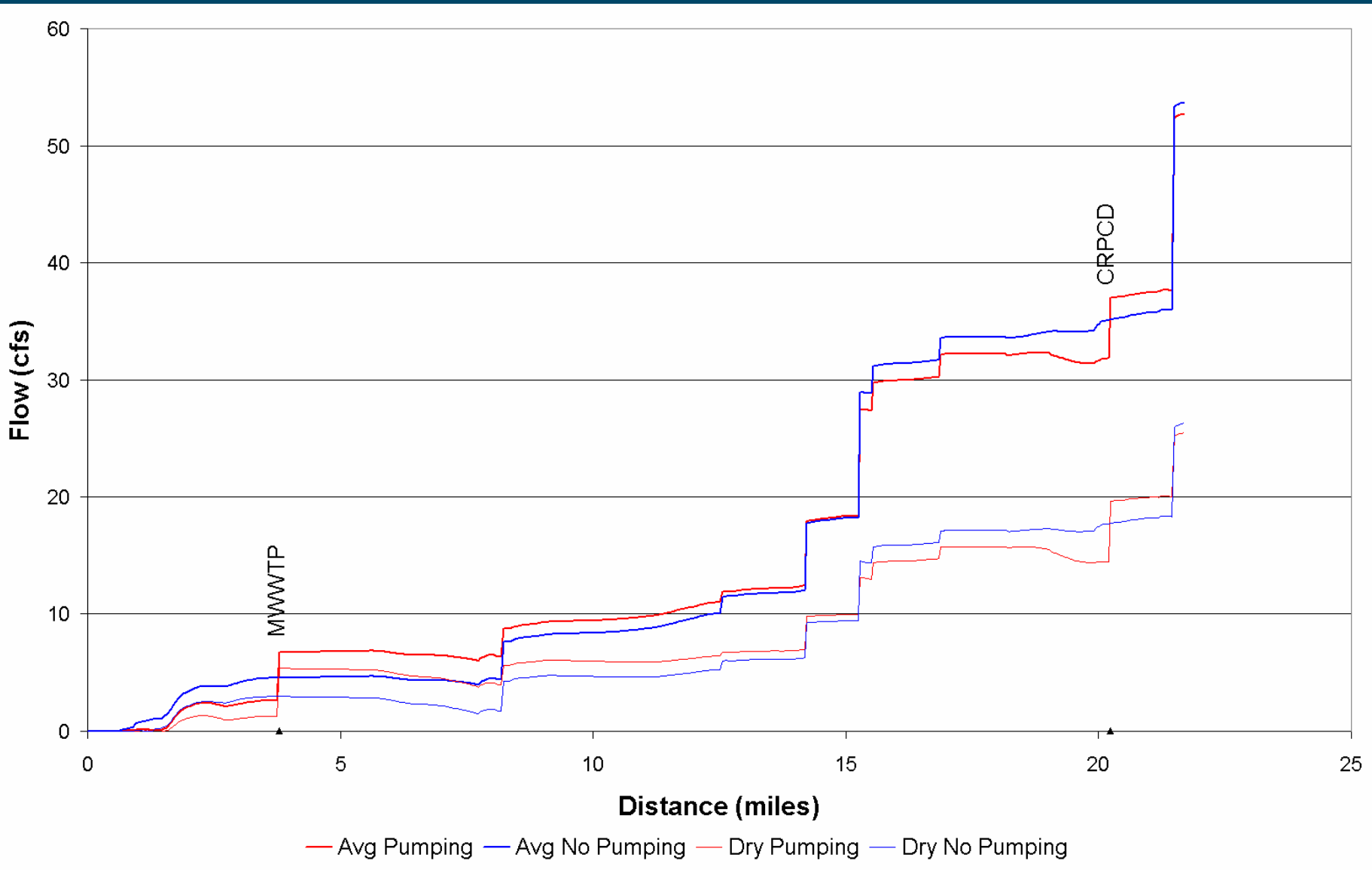
Supply vs. Demand

- Science
  - water supply for rivers is threatened in the summer because withdrawals can exceed recharge especially in a dry year
  - streams are at the top of the aquifer so they can go dry even though groundwater is still available for supply

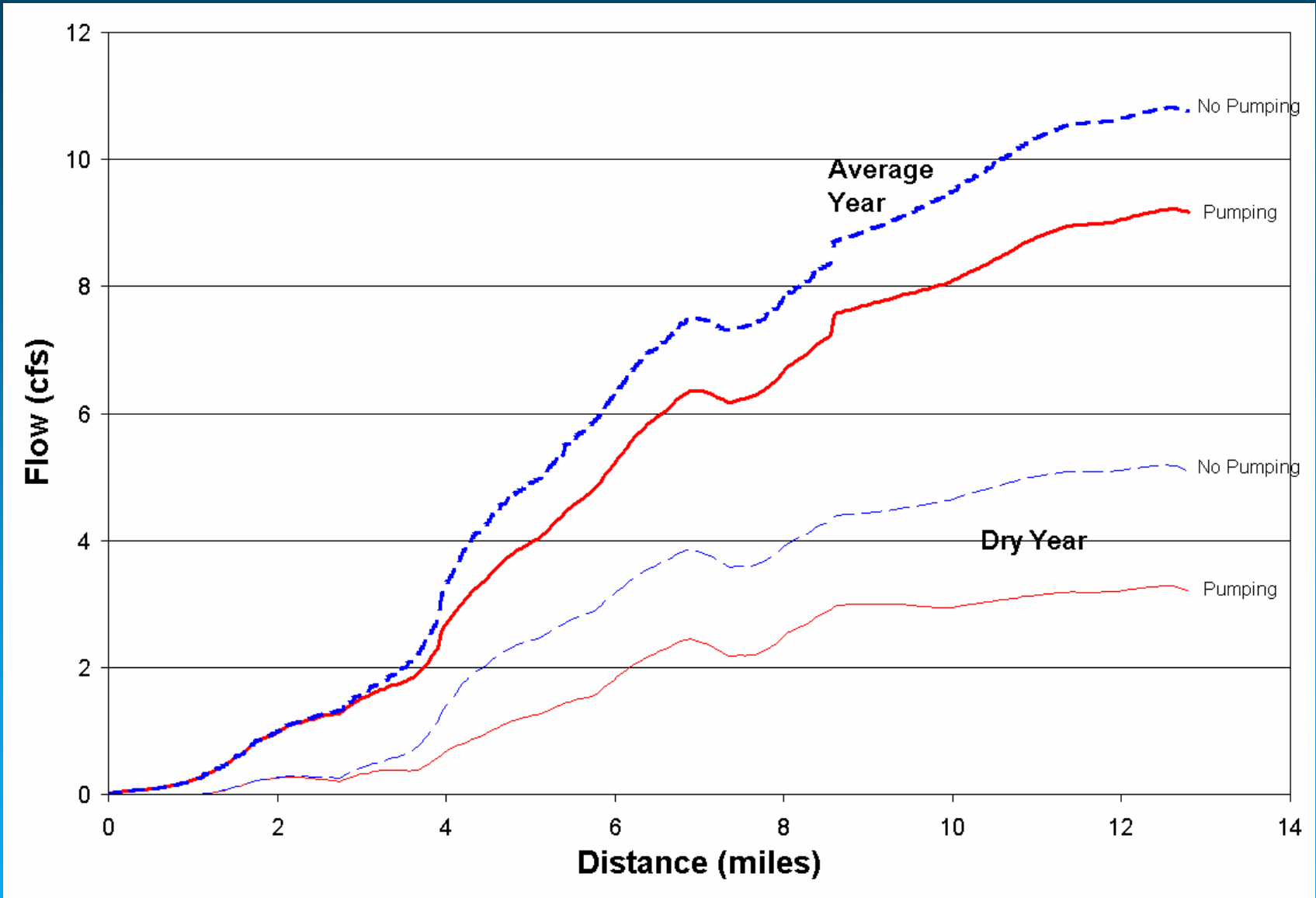
Withdrawals

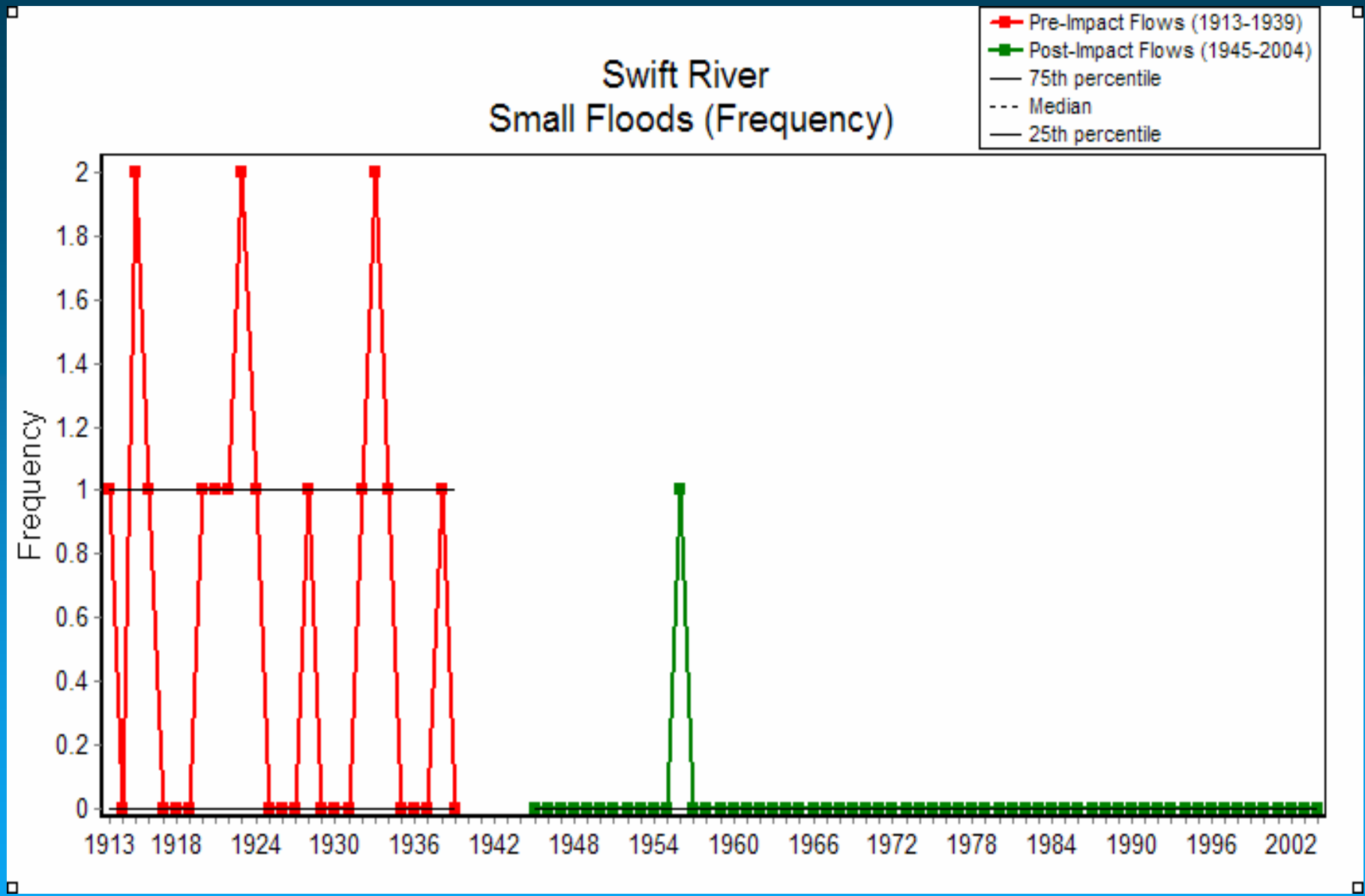
- Misconceptions
  - wells far from the river have no effect
  - wells in a confined aquifer have no effect
  - effect of withdrawals on rivers is minor
  - surface water reservoirs have no impact at all

September Baseflow – Upper Charles R



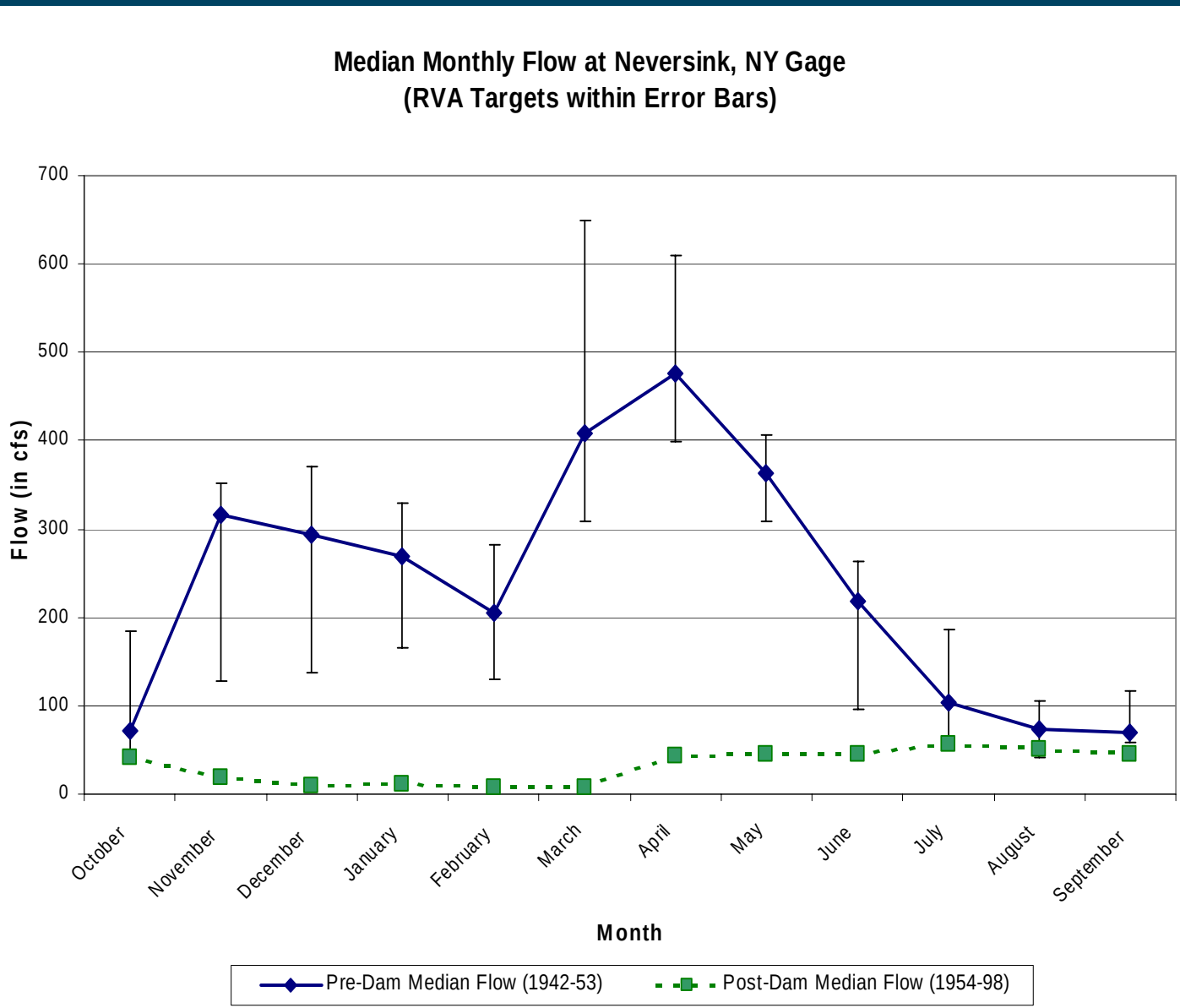
September Baseflow –Mine Brook




Swift River
Small Floods (Frequency)
Pre-Impact Flows (1913-1939)
Post-Impact Flows (1945-2004)
75th percentile
Median
25th percentile
Frequency
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1913
1918
1924
1930
1936
1942
1948
1954
1960
1966
1972
1978
1984
1990
1996
2002

Flow Alteration in the Upper Delaware

- Typical NYC diversion of over 50% at the 3 reservoirs: 250 bgal annual avg



Withdrawals

- Science
  - all well withdrawals affect the river, just timing of the impact is shifted
  - impact larger for headwaters & tributaries
  - impact larger in the summer for streamside wells
  - cumulative impact from multiple withdrawals can be large
  - reservoir impact can be 100% in the summer

Irrigation

- Misconception
  - lawns need to be watered frequently to be maintained
  - lawn irrigation returns most of the water to the groundwater

Irrigation of Residential Grass

Recommended Depth = 1.0 in/wk

Min Available Water (grass on sand) = 1”

Max Irrig Freq = 1.0 in/1.0 in/wk= 1 week

Irrigation

- Science
  - lawns in the NE only need about 1.0” of water every week (or more) during the summer (includes rainfall)
  - about 75% of irrigation water is lost to the atmosphere via evapotranspiration

Mitigation of Impacts on Streamflow

- Conservation
  - less demand
- Restoration
  - more recharge
- Optimization
  - improved management

Conservation

- Misconceptions
  - per capita water use in MA is already low
  - conservation would yield only 10% savings
  - conservation is a costly alternative

Conservation vs. Recharge

- Science
  - rivers respond to total use not per capita use
  - outdoor conservation could save 30-40% in in summer with little cost
  - cost comparisons:
    - conservation < 0.4 c/gal (double current)
    - stormwater recharge ~ 1.5-13.5 c/gal[1]
    - wastewater recharge ~ 3.0-8.0 c/gal[2]

[1] "Preliminary Data Summary of Urban Storm Water Best Management Practices", Chap. 6, EPA, 1999 [assumed 10 year life @ 5%].

[2] Bellingham CWRMP—$10 mil extra to recharge 0.4 mgd [assumed 20 year life @ 5%].

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